

Applications and Accomplishments in Internet of Things as the Cutting-edge Technology: An overview

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Abstract:

The Internet has propelled the globe to unprecedented heights, with a revolution occurring virtually every minute. Among these, the Internet of Things is a popular technology currently (IoT). It is, as the name indicates, the internet's connectedness of many Things, a supreme and amazing combination of hardware and software. IoT has advanced swiftly with the growth of autonomous models in every area, whether it is for daily usage or industrial application. The employment of diverse technologies and programming languages advanced industrial activity while requiring less expenditure. IoT has brought about dramatic changes in the fields of medical care, agriculture, defense and military, industry, and so on. This paper conveys emphasizes the growth of IoT along with the change it brought to the technological world with a strong review.

Keywords: IoT; Embedded System; Application-focused area; Network Stack; IoHT; AIoT

Introduction:

Kevin Ashton created the concept "Internet of Things" in 1999 to refer to supply chain management with RFID-tagged or barcoded item(s) that boost organizational efficiency and accountability. "If we had computers that understood all there was to know about things—using data they obtained without any help from us—we would be able to monitor and measure everything and greatly minimize waste, loss, and expense," Ashton remarked in an RFID journal article (June 22, 2009). We'd know when items required replacing, repairing, or recalling, as well as when they were beyond their prime" [1].

The term Internet of Things (IoT) has developed over the past few years as one of the popular 'technology buzz' terms. Today, data is everything, here this new cloud-based technology help to process the generated data and also generate the graphical representation, triggered any action basic on the captured data, and interestingly the all procedure is done in real-time. It's the technology that not only senses the data and makes some procedural work but also, it's used to transfer the meaningful data between two devices. Nowadays IoT is used in various sectors like agriculture, assets tracking, energy sector, safety and security, defense, embedded applications, education, waste management, healthcare products, telemedicine, smart cities etc.

Things in IoT:

Things refer to a check of devices in the context of the Internet of Things. Even humans in the loop can become a thing at times. For anything to be considered a thing. It is necessary for something to be identified as a "thing" in order for it to exist. A network's "things" can monitor and measure. It's possible that a humidity sensor will become a reality. Things have the ability to share data with other connected devices.

The data might be kept on a centralized server (or in the cloud), processed there, and then a control action taken. Temperature sensors, pressure sensors, humidity sensors, and other well-known "things" are only a few examples.

$$\text{"THINGS"} = \text{HARDWARE} + \text{SOFTWARE} + \text{SERVICE}$$

The collected sensors data is forwarded to the server (cloud or a local sever). Based on the analysis, the corresponding trigger is triggered. These "things" are the heart of the all IoT devices.

Hardware:

The Internet of Things (IoT) is a collection of various technologies and gadgets. Sensors, embedded systems (such as the microcontroller board), data analysis, mobile and mobile internet, security, and cloud storage (computing) elements and protocols have all become enabling technologies.

Sensors are at the heart of all Internet of Things (IoT) applications. They detect the surroundings and retrieve data, as the name implies. Sensors serve as the foundation for all IoT applications. There are various sensors on the market, and it is critical to understand them in order to construct a complete/ similar IoT system.

An embedded computing board a very important component to bring IoT design to reality. From the proof of concept to the prototype, all these are linked with the computing board available in the market are driven by the microcontrollers or processors. Some of the boards are Raspberry Pi, Arduino, NodeMcu, Intel Edison, Intel UP Squared* Grove* IoT Development Kit.

Software:

As stated, earlier IoT is the collection of hardware's like sensors and embedded systems, the interface needed for the communication for the hardware and the user is the software. There are master application software's which are responsible for the processes like data collection, device integration, real time analytics within the IoT network. The complex interaction between the hardware and the software provide users with an experience of flawless connectivity. Worldwide IoT companies mainly focus on how to make readily available daily use things handier and more useful. The software for this purpose is widely based on cloud computing and blockchain technologies. This software is made using a wide range of software's and programming languages like C, C++, Java, Python, B# etc. C and C++ programming languages are having their roots in embedded systems. On the other hand, python is slowly spreading speeded in embedded control and IoT system, especially in Raspberry Pi processor.

Service:

IaaS (Infrastructure-as-a-Service):

Virtual computers can be chosen over actual machines in this cloud service. It's a type of cloud computing that uses the Internet to deliver virtualized computer resources. Users control the computers, choose the operating system and underlying programmers, and pay for what they use.

PaaS (Platform-as-a-Service):

This is a cloud computing approach in which a cloud service provider (a third-party provider) provides customers with the hardware and software resources they need to create applications over the internet. The hardware and software are hosted on the PaaS provider's own infrastructure. Users must create, administer, and maintain applications that meet their needs.

SaaS (Software-as-a-Service):

In this model, a complete software application is provided to the user. It can also be called application as a service. This service can be availed by paying a monthly, yearly, etc. subscription. Some well-known service providers in the market are Amazon web services, Azure and Adafruit.

Growth:

From the “Forecast end-user spending on IoT solutions worldwide from 2017 to 2025” presentation (Fig. 1), one can see that IoT has a prodigious growth has predicted that by 2025. By the end of 2019, the worldwide market for Internet of Things (IoT) end-user explanations is appraised to reach 212

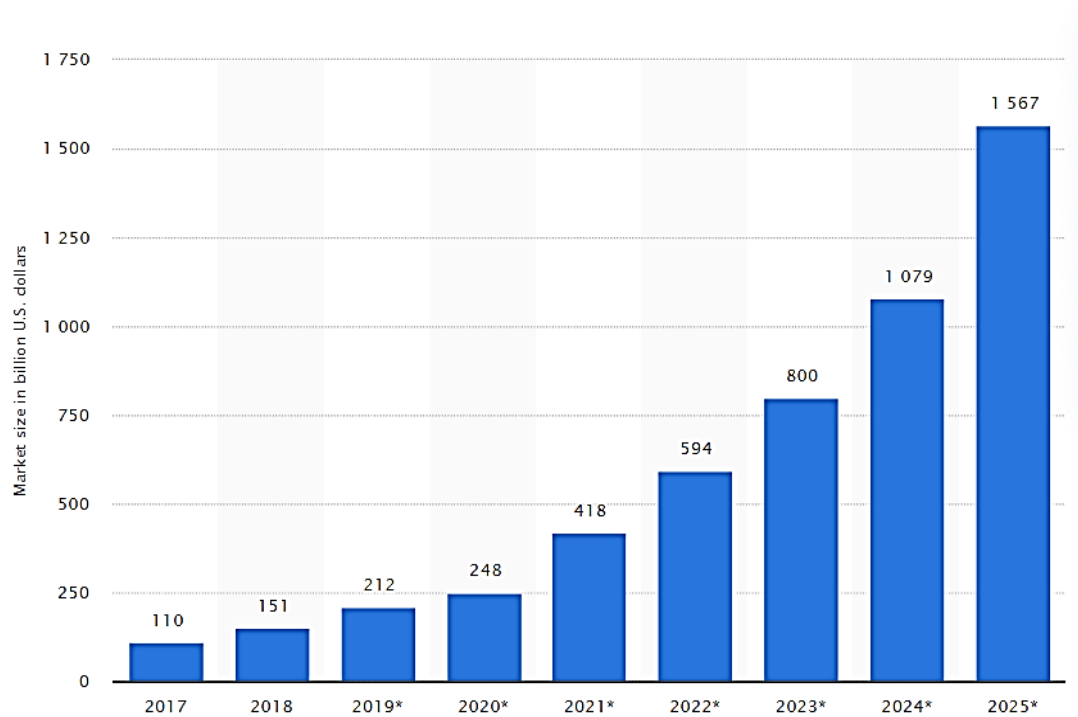


Figure 1: Spending on IoT by end-users throughout the world from 2017 to 2025

billion U.S. dollars Market returns for technology reached \$100 billion for the first time in 2017, and forecasts show that this figure might climb to almost 1.6 trillion by 2025. [2]. CISCO BSG has predicted that by 2020, people would be using 50 billion smart objects. Also, surprising fact is that each person would have six objects connected to the Internet. The projection for 2020 indicates a steep growth in the use of smart objects in comparison 2003. Not only CISCO, but many major forums and organizations realized the potential of IoT development and have made or planed huge investments [3].

Related Works:

In paper [4], presented an overview of important IoT approaches. This review included architecture levels such as the service layer, network layer, interface layer and perception layer. Advantage of this assessment is that it presents extensive open questions and difficulties in the Internet of Things; nevertheless, the compatibility of each technique in IoT applications was not taken into account.

In paper [5], offered an overview of the topic of package configuration of Internet Protocol (IP) smart IoT items the writers conducted a thorough examination of topics for example smart IoT service composition, service modelling, target platforms, target Scalability and other essential quality elements were not investigated. applications, and object systems methodologies for IoT IPs. The key drawback of this study is that the assessment elements such as availability, reaction time, pricing, and scalability as significant excellence factors were not examined.

In paper [6], A review on the IoT was provided by This research looks at subjects including Service Oriented Architecture (SOA), Wireless Sensor Networks (WSN), social computing and health-care systems. The fundamental shortcoming of this research is that it does not include any examination of assessment metrics Quality aspects in this sector include availability, energy usage, cost, reaction time, and reliability. A study on the IoT was provided by This research looks at subjects including Service Oriented Architecture (SOA), Wireless Sensor Networks (WSN), social computing and health-care systems. The fundamental shortcoming of this research is that it does not include any examination of assessment metrics such as availability, cost, energy consumption, reaction time, and dependability as excellence aspects in this domain.

IoT Stack:

In IoT, from the physical layer (PHY layer) to the application layer, the model is made up of five levels. Each layer has its own set of capabilities: the physical and data-link levels define RF functionality, the network layer specifies routing and security capabilities, and the transport and application layers define the protocol's instructions.

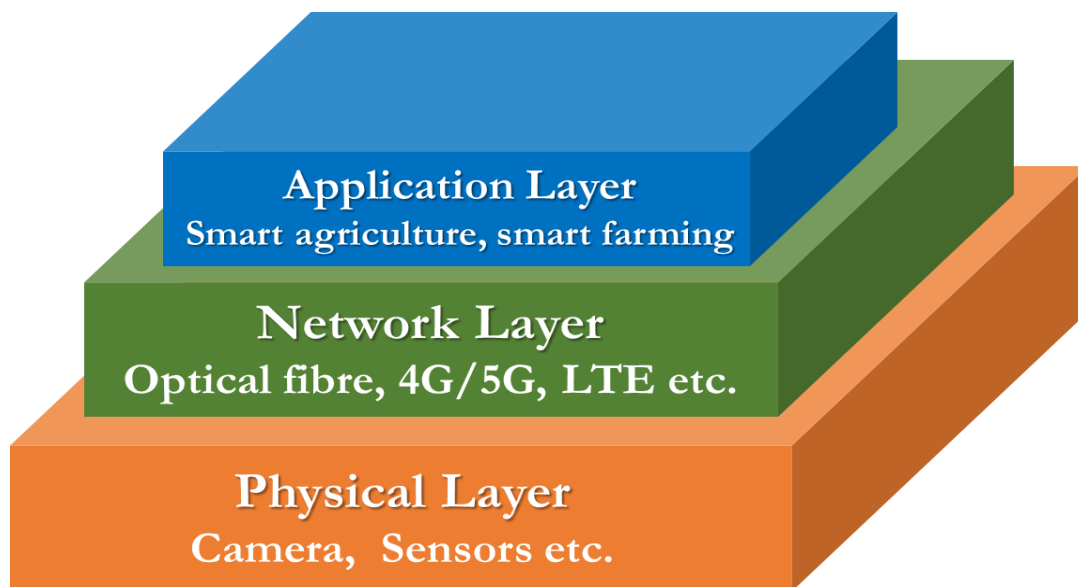


Figure 2 Basic Layer of IOT stack

Physical Layer:

Several terminal devices, cameras, sensors, Wireless Sensor Networks (WSN), Radio Frequency Identification (RFID) labels and readers, Near Field Communications (NFC) devices, and so on make up the physical layer [7]. Sensors are employed in this layer to collect data on wind speed, temperature, nutrient levels, insect pests, plant diseases, humidity and other factors. Embedded devices control the compiled data, which is then uploaded to a higher layer for further processing and examination. Agricultural and animal items are monitored, controlled, and recognised using various sensors and terminal devices. WSNs are often used to govern and monitor storage and logistics services, for example [4]. RFID technologies, on the other hand, are the most important pattern for networked devices. RFID tags hold information in the form of an Electronic Product Code (EPC), which is subsequently read, activated, and controlled by RFID readers. As a result, WSN, RFID, and NFC technologies are employed to play a key role in the agricultural sector by contributing to item identification, tracking, monitoring, control, and data storage on active or passive devices.

Network Layer:

In order to build a network, sensors and devices are required at the network layer to connect with neighbouring nodes and a gateway. Sensor nodes at this layer collaborate and link with other nodes and gateways in a network to transfer data to a distant structure, where it is stored, analysed, processed, and disseminated for usable information [8].

On the global Internet, there are presently two sorts of internet protocol versions in use to carry data from one technological equipment to another. IPv4 is made up of 32 bits. IPv4 addresses are 64 bits long, but IPv6 addresses are 128 bits long. addresses, which is more efficient since it can process billions of addresses devices and may issue a unique IP address to each one.

(1) Dual-Stack, (2) Tunneling, (3) Network Address Translation Protocol Translation [9-14].

Application Layer:

The application layer is the top level of the IoT architecture, where the benefits and benefits of IoT are pushed outward. This layer has a plethora of brilliant stages or systems for controlling and monitoring soil conditions, water and nutrient levels, plants, and animals. These layers are also utilised to promote early detection and organisation of illnesses and insect pests, infestation, and agricultural creation safety controllability, resulting in increased manufacturing efficiency [15].

Application of IOT:

This segment gives a mechanical overview of the IoT applications chosen for current investigations utilizing the SLR method. Figure 2, depicts a complete taxonomy of Internet of Things applications, which includes health-care, environmental, smart city, commercial, industrial, and general elements [16, 17]. Because each type of IoT application faces unique challenges, it's critical to focus on developing effective solutions to make IoT applications more efficient and useable in real-world IoT settings. Smart city applications face critical difficulties such as semantic-aware mobile crowd-sensing, location finding,

vehicular monitoring, context-aware or QoS-aware service composition, scalable IoT platforms, managing expanding heterogeneous data streams, and many more. As a consequence, the categorization proposed in this paper is based on a variety of IoT applications, each of which has specific subjunctions explored and handled in the selected research papers. When it comes to the challenges and concerns that arise in various categories of IoT applications, we first look at the type of IoT applications. Of course, the suggested taxonomy's general elements are applicable in all IoT application fields, such as applied and systematical software, assessment procedures, and IoT application performance prediction [18]. To put it another way, the illustrated analyses of broad elements offered a fresh conceptual method for use in the creation of any form of IoT application. Fig 3 Describes a different application domain of IOT.

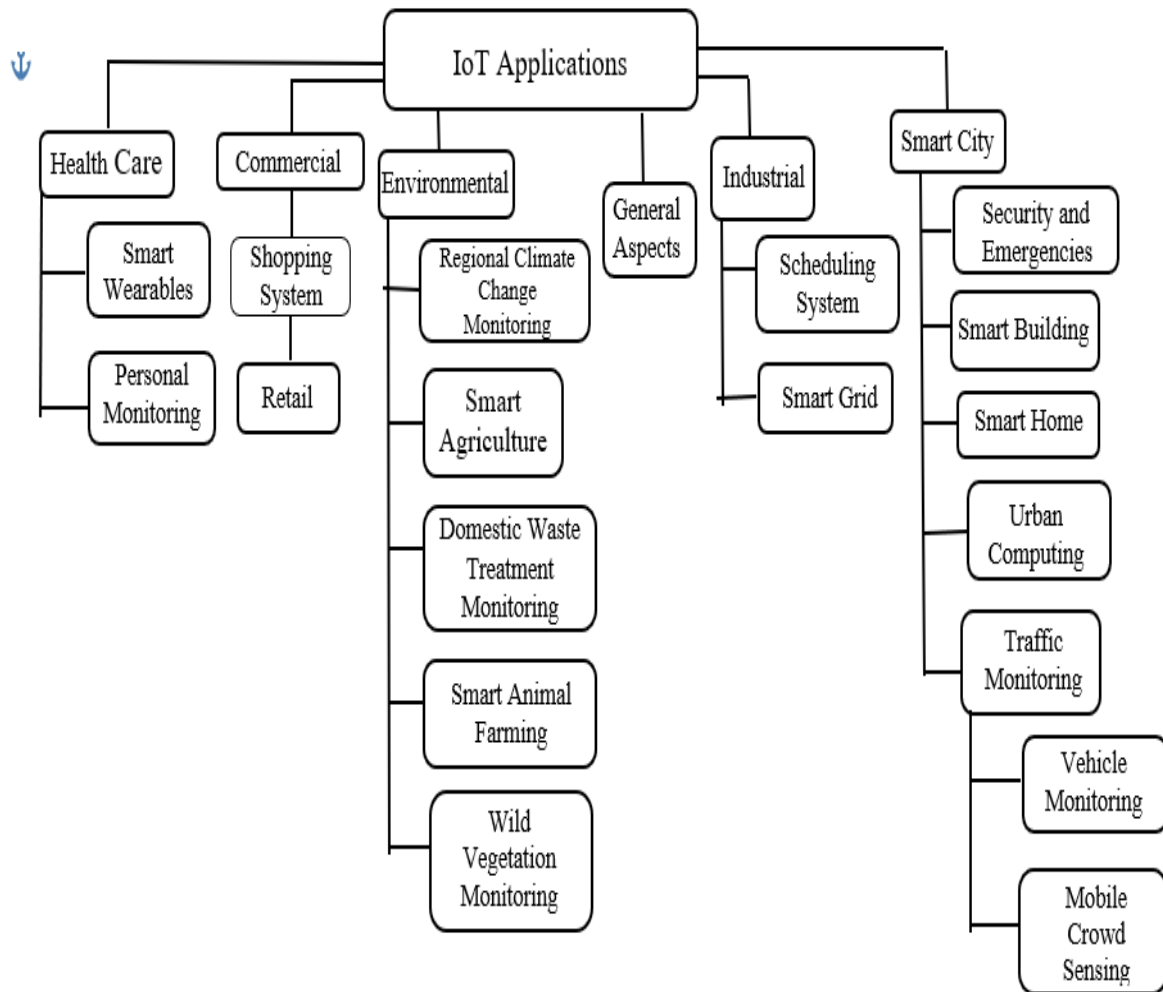


Figure 3: Versatile domain of IOT applications

Figure 4, offers an assessment of the proportion of IoT submissions up to now rendering to the taxonomy providing in section 4. We investigated six IoT application domains: health-care, environmental, commercial, smart city, industrial, and general aspects. In the literature, the smart city method has the largest percentage of application domains by 30 percent. Of course, health-care applications account for

20% of IoT usage, commercial applications account for 14%, environmental applications account for 12%, general applications account for 12%, and industrial applications account for 10%. [19]

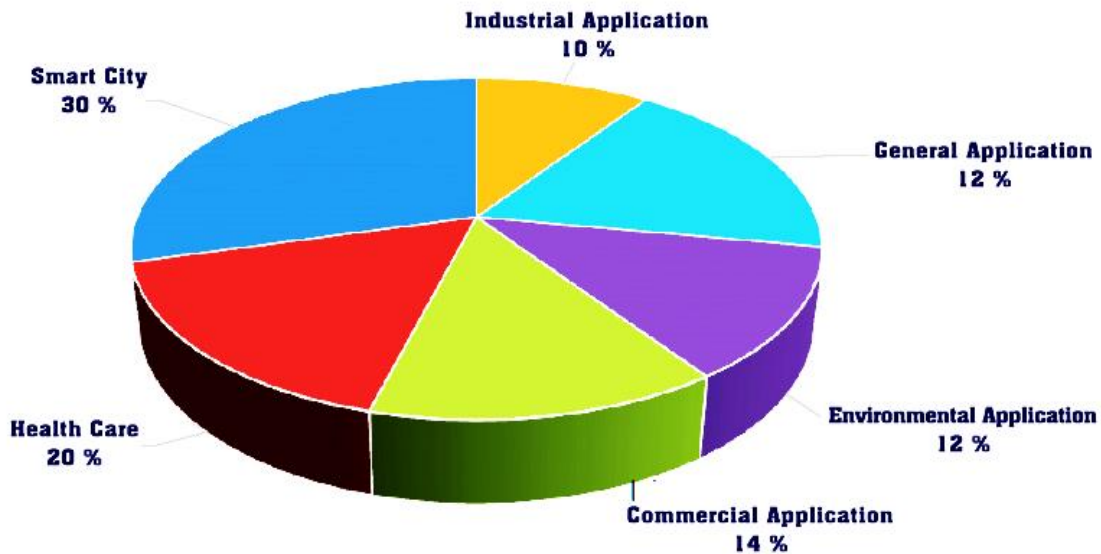


Figure 4: Percentage of the presented IoT applications

IoT for smart agriculture (AIoT):

Smart agriculture is a modern farming idea that uses IoT technologies to increase agricultural output. Farmers may successfully employ fertilizers and other resources to increase the quality and quantity of their crops by using smart farming. Farmers are unable to stay current in the field 24 hours a day. Furthermore, farmers may not have access to the knowledge needed to employ various instruments to determine the optimal ecological conditions for their crops. IoT provides them with an automated system that can work without human guidance and can instruct them on how to cope with various types of challenges they may encounter while farming. It has the power to disseminate and notify farmers even when they are not on the ground, allowing them to cultivate additional farmland and increase their yield. By 2050, it is predicted that the global population would reach 9 billion [20-24]. As a result, IoT applications are essential for farming to feed such a huge population and efficiently employ farmland and other assets, which are rare in some areas. Random weather events are harming crops and farmers are losing money as a result of global warming [25-32]. The IoT Smart Farming application will allow them to take immediate decisions to prevent this from happening and all the protocol is shown over Figure 5.

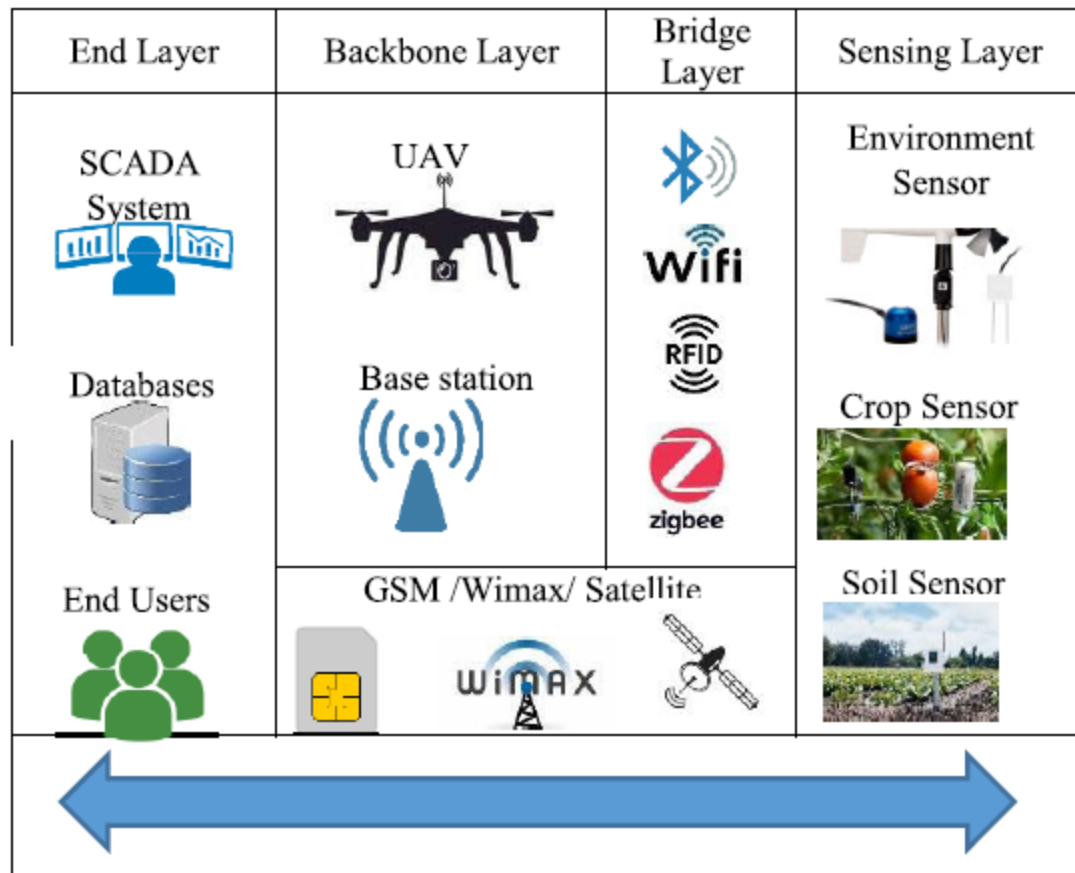


Figure 5: Utility model of AIOT

Sensor-equipped equipment, wireless communication technologies, internet connectivity sensed and transferred data, and so on are all important components of Agricultural IoT (AIoT). Wireless communication technology plays a critical role in the efficient configuration of IoT systems, which may be classified by transmission distance, spectrum, and application situations. As illustrated, the IoT is built on five layers: the physical layer, which is responsible for sensing, the network layer, which is responsible for data transport, and the application layer, which is responsible for data storage and modification [27].

IoT for Health Care (IoHT):

The Internet of Health Things (IoHT) was born out of the development of sensor-based applications in healthcare, which enhances patient safety, staff morale, and operational efficiency. In recent years, edge-fog computing has advanced significantly, allowing the integration of many intelligent devices with sensors to ensure seamless data transit. Edge-fog computing, on the other hand, finds it difficult to address a variety of IoHT scenarios, such as effective disease management, emergency response management, and so on. Existing designs' main drawback is their limited scalability and inability to satisfy the demands of hierarchical computing systems for IoHT. This is because latency-sensitive applications usually necessitate the measurement and transmission of large volumes of data to data centers, resulting in delays and poorer

output. Edge-fog computing is used in this research to provide a novel edge-fog computing paradigm for machine learning ensemble convergence. The proposed architecture functions as a fog system that handles data from a variety of sources to effectively regulate diseases. [33].

According to the National Council on Aging (NCOA), the incidence of fatalities among the elderly has reached a dangerous level, with an older person being treated for a fall every 11 seconds. Furthermore, every 19 minutes, an older person dies as a result of a fall. Most of the elderly people suffer from joint pain, knee pain, back pain; they are frequently the ones who are not able to walk properly and are mostly confined to bed. Falls are caused by a variety of catastrophic consequences, including immobility, bone fragility, and chronic health problems. As the healing capacity in old.

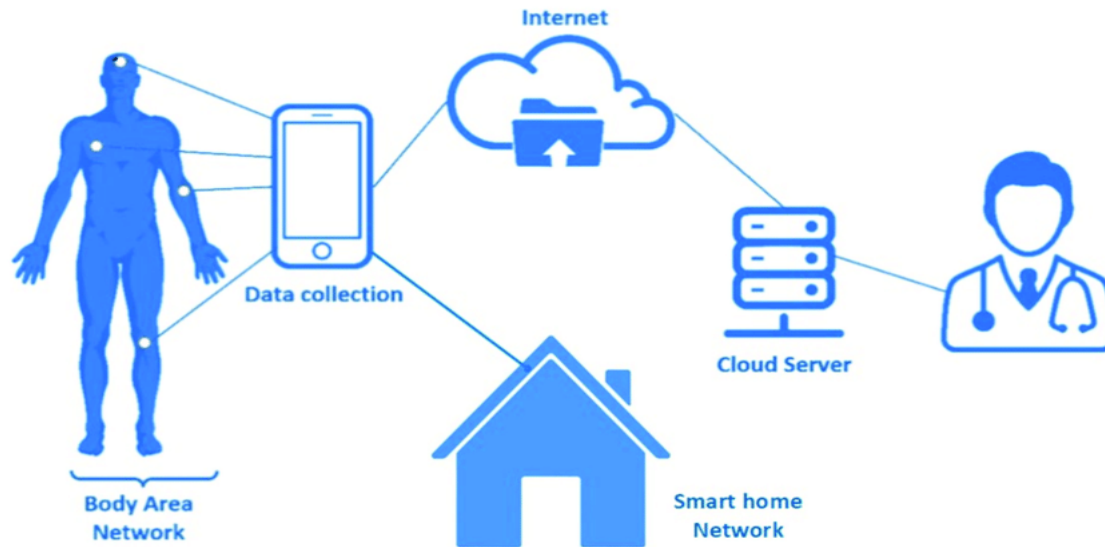


Figure 6: Basic model of IOHT

people diminish due to ageing; falls can be fatal for them. Falls, in particular, represent a major threat to elderly adults who are suffering from heart disease. When such persons fall unexpectedly, they run the danger of developing Tachyarrhythmia, a heart condition in which the afflicted person's heartbeat accelerates to more than 100 beats per minute, potentially resulting in cardiac arrest. There is an inexpensive and accessible device that can track a person's mobility and identify a fall in order to prevent these sorts of dangers in the elderly [34]. Figure 6 demonstrate a clear model of IoHT.

Conclusion:

Keeping up on today's scenario we are constantly heading towards automation in every field and the future of this progression is IoT. IoT has marked its position in every aspect of general life like in agriculture it impersonated itself as AIoT and in Health care it disguised itself as IoHT, for industry it emerged as IIoT. It also has a great impact in the field of manufacturing logistics, mining and metals, oil and gas energy, aviation etc. It abetted these industries in global monitoring as well the collection of real time data where the expenditure of this technological use is very much reasonable. Not only this, the invention of UAV (Unnamed Arial Vehicle) system laid a huge impact in defense and military services. In fact, IoT is emerging with new upgradations in every second with the help of sensors and actuators which itself is a great field of research. Starting from crop protection to health monitoring, the branches of IoT are widely

spread. In the field of Hospitality, it has left behind the process of keeping track of sugar level or pressure of a person through sensors and health watch and has advanced to the checking of early stage cancer diseases. All this advanced automation is controlled with the help of some bygone networking technology which is increasing the threat of security for which the activity of hacking is taking place expeditiously. But as the technology is advancing the concept of block chain, artificial intelligence, machine learning is rapidly used to cover the loopholes of old networking mechanization. Our Paper enriched a review study of IOT and its vast application on different domains.

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